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U. S. DEPARTMENT OF AGRICULTURE.

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OF

THE CHEMIST

FOR

1900.

BY

H. W. WILEY.

[FROM ANNUAL REPORTS, DEPARTMENT OF AGRICULTURE.]



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REPORT OF THE CHEMIST.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF CHEMISTRY,
Washington, D. C., September 1, 1900.

SIR: In harmony with the requirements of your circular letter of July 2 last, I beg to submit the following report of the Division of Chemistry for the fiscal year ended June 30, 1900. I also include, in accordance with your request, an outline of the work proposed for the current year, and plans and estimates for the fiscal year ending June 30, 1902.

Respectfully,

H. W. WILEY,
Chemist.

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR.

INVESTIGATION OF THE COMPOSITION AND ADULTERATION OF FOODS.

The work of the Division in this branch of investigation during the past fiscal year has been directed chiefly to a study of the composition and adulteration of preserved meats. The analytical data have been completed, and the large amount of clerical work necessary for an appropriate elaboration, comparison, and final tabulation of the results obtained is nearly finished. The text to accompany the tables is also almost ready for the printer. It is hoped that the report of the investigation may be ready for distribution before the close of the present calendar year.

An investigation that involves an exposition of the relative merits of manufactured products of a given class must be carefully planned, so as to avoid the injustice of omitting the goods of one or more manufacturers. Such an omission would work an injustice to the public and to the individual manufacturers, whether the omitted products be good, bad, or indifferent. It has therefore been the endeavor of this Division, in undertaking investigations of this kind, to secure samples of every brand obtainable and belonging to the class of goods under investigation. The degree of our success in this regard and the

extent of the investigation in this case are both well exhibited in the following:

Classified list of samples examined.

Beef (roast, boiled, corned, dried, and smoked)	54
Tongue (calf, lamb, ox, and luncheon)	16
Ham and bacon	15
Chicken, turkey, duck, and goose	35
Game	10
Potted and deviled goods (beef, chicken, game, ham, mixed, tongue, and turkey)	81
Sausage (Frankfurt, Vienna, and miscellaneous)	25
Patés, purées, etc.	31
Soups	156
Meat extracts	47
Miscellaneous meat preparations	43
Total	513

In the course of the work 39 samples of horse meat were obtained and used for various analytical investigations, made for the purpose of finding a ready and certain means of detecting the presence of horseflesh in commercial meat products. Including these, the total number of samples examined is 552.

SOIL STUDIES.

COMPILATION AND ARRANGEMENT OF THE DATA OF SOIL STUDIES.

The first series of studies relating to the relation between soil composition and the character and amount of crop produced has been completed, and the data obtained have been partially classified and studied. This series of observations has lasted for five years, and the analytical data collected are very extensive. These data include the study of the structure of the soil as a whole, the determination of the parts of the soil soluble in various chemical reagents, a study of the physical texture of the soils under experiment, and the analyses of the crops grown on the soils over a period of five years. By the alternation of a crop of buckwheat with oats and beans it has been possible to secure two harvests a year, the buckwheat following the first two crops. The total number of soils under experiment is 177. Since two crops were obtained from each soil each year, the total number of separate harvests obtained and analyzed is 1,770. The proper arrangement and study of such a mass of analytical data is a work of great magnitude, and will require some time for completion.

PLANT DISEASES WHICH HAVE BEEN DEVELOPED DURING SOIL EXPERIMENTS, AND METHODS OF COMBATING THEM.

During the summer of 1899 it was discovered that the beans grown upon the soils contained in several pots were being preyed upon by a certain parasitic fungus whose ravages greatly detracted from the value of the experiments, the plants in many cases being so dwarfed as to make it impossible to place any reliable interpretation whatever upon the results. At our request the source of the trouble was very carefully investigated by the Division of Vegetable Physiology and Pathology, and it was found that the beans planted were affected by a species of *Fusarium*, a parasitic fungus which is closely related to the one which causes the cotton and melon diseases of the South.

In order to destroy the fungus and to obtain, if possible, a normal growth during the present season, it was decided to sterilize the soils

of all the pots by means of heat and to reinoculate them by means of a small portion of soil selected from a field which might reasonably be presumed to be free from the fungus which had caused the trouble. This reinoculation was of course necessary to renew within the soils those forms of lower plant life which are helpful to the growing plants.

A plan was finally devised by which this sterilization and inoculation could be carried out, although the treatment of 177 portions of soil by these processes was a very laborious task. Three dozen covered sheet-iron pans were obtained, of such size that each pan would hold the soil contained in one pot. The soils contained in these pans were subjected to heat on each of three successive days, the temperature being carried approximately to 100° C. during the course of each heating. The soils were kept as moist as possible during the process, inasmuch as sterilization by heating is more effective when the material to be sterilized is kept moist. A large drying oven, already in use in the laboratory for other purposes, was found very convenient for heating the pans of soil during the sterilization, as the oven is of such a size as to accommodate from ten to twelve pans at one time. The pots were also sterilized by washing, steaming, dipping in bichlorid of mercury solution, and then thoroughly washing. The soils contained in the pans, after sterilization, were mixed with 100 grams of the soil used as the inoculating material preparatory to being returned to the pots.

While the growth of the plants during the present season shows that the destructive work of this fungus has been practically eliminated, there is abundant evidence that several causes contributed to the poor growth of the bean plants in several of the pots. The cause or combination of causes is yet somewhat obscure, but the experience of this season gives several clues to the means of ultimately overcoming this difficulty. The growth of the oats in the pots planted in that crop has been very satisfactory.

STUDY OF SOIL BACTERIA USEFUL OR HURTFUL IN AGRICULTURE.

Since the discovery of the nitrifying organisms by Schloessing and Müntz in 1877, the attention of agricultural scientists has been directed to the study of those organisms in the soil which are either helpful or harmful to the higher forms of plant life. There has been developed an immense literature on the subject, which, however, is now scattered through a great number of monographs and scientific periodicals of recent date. There is no exhaustive treatise in any language which reviews the entire subject and treats of the agricultural importance of these organisms, including the best methods of enabling the farmers to derive the greatest amount of benefit from the useful ones and to reduce the activity of the harmful ones to a minimum. It has been my purpose, since the authorization was given me and the necessary appropriations first provided in 1894, to compile this information in such a form that it would be useful to the American farmer as well as to our very large corps of scientific investigators.

I have also endeavored, by means of investigations in the laboratory, to add to our knowledge of these organisms and their relations to agricultural operations. A considerable amount of time has already been devoted to the subject, and the systematic review of the literature bearing upon it is now nearing completion. It is hoped that that part of the work having reference particularly to the nitrifying organisms may be ready for the printer within a few months.

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

COOPERATION WITH THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

The patronage of the Department heretofore extended to the Association of Official Agricultural Chemists has been continued, and that useful association, by the many years of its close relationship to the Department, may almost be considered as organically connected with it. The Division of Chemistry has also continued its active cooperation in the work of the association. Among the referees and associate referees of the association may be found the following members of the Division:

Referees.—E. G. Runyan, phosphoric acid; William H. Krug, foods and feeding stuffs.

Associate referees.—L. S. Munson, potash; W. D. Bigelow, liquor and food adulteration; G. L. Spencer, sugar.

The work of the members of the Division in this connection is not of a routine nature only, but is partaking more and more of the nature of research. There is a growing tendency to look to this Division for a study of new methods, for the purpose of verification, and for all those methods of research which are necessary to the advancement of agricultural chemistry. To this end authority has been given to associate the chemists of the experiment stations and agricultural colleges in the work of the Department. In no other way has this cooperation proved so effective as through the various channels of activity afforded by the Association of Official Agricultural Chemists.

In connection with this work, the Division has carried on investigations in the ordinary routine methods of analysis of soils, fertilizers, and feeding stuffs; has given special attention to methods for the analysis of tanning materials; and has in progress an extensive study of methods for the analysis of insecticides, including therewith an investigation of the composition and efficacy of insecticides now on the market. In this latter work we have had the active cooperation of the Division of Entomology.

As a result of the patronage of the Department of Agriculture, which has been extended to the Association of Official Agricultural Chemists now for a period of sixteen years, the United States has the best organized, as well as the most numerous, corps of agricultural chemists of any nation of the world. While by no means claiming that our methods are the best, they yield results which are more easily comparable among themselves than similar analytical data of any other country. By using the same methods in the same way and practically under the same conditions, we secure results which are just, not only because they very closely approach absolute accuracy, but also because they are uniform and of general application.

RECOGNITION OF THE WORK OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS BY OTHER COUNTRIES.

At the Fourth International Congress of Applied Chemistry, held in Paris in July, 1900, the methods of analysis of the Association of Official Agricultural Chemists were recognized as being of common application, and citations thereto were ordered to be printed as a part of the provisional international methods adopted by the congress.

The International Association of Leather Trades' Chemists, which met in Paris in August, 1900, adopted a large part of the official methods for the analysis of tanning materials which had been previously approved by the Association of Official Agricultural Chemists, and voted that other portions of these methods be recommended for further trial.

COMPILATION AND COMPARISON OF ANALYTICAL DATA.

An important part of the present and future work of the Division consists in the collection, comparison, and tabulation for publication of analytical data relative to substances of commercial importance or scientific interest. Data of this kind, selected with proper care and tabulated in a form for ready reference and comparison, are of the highest value in arriving at standards for various agricultural products. During the year a very exhaustive and valuable compilation of analyses of American wines has been prepared and sent to the printer, to be published as a bulletin of this Division.

A filing cabinet has been obtained and a system devised for the collection and recording of data of this kind in such a manner that they will be readily accessible and of the highest utility in connection with the correspondence and other routine work of the offices and laboratories of the Division. Moreover, when material accumulated on a given subject is sufficient to justify its publication, it will be in form for printing immediately.

UTILIZATION OF THE STALKS OF INDIAN CORN.

The possibility of utilizing the stalks of indian corn as a cattle food has long occupied the attention of our agricultural chemists. A large amount of experimental and analytical work has been done in this direction by the experiment stations, notably by those of Maryland and Pennsylvania. Our work has been directed chiefly to the study of the rations composed of the fine-ground stalks of maize mixed with blood, molasses, ground bone, indian-corn meal, other cereal products, and various other ingredients.

The previous grinding of the stalk is a primary necessity, since otherwise it can not be properly masticated. When convenient, it is also advisable to remove the pith, which can be used to better advantage for other industrial applications. The ground stalk has a nutritive value equal to that of coarse hay and an absorbent power for blood, molasses, and other liquids which makes it an ideal vehicle for offering these bodies in an appropriate form for consumption to domesticated animals. The value of both blood and molasses as cattle foods has long been established, but until the employment of fine-ground indian-corn stalks as an absorbent was proposed no entirely satisfactory method of utilizing these products was known.

During the past year many different rations have been mixed and subjected to analytical study, with the result of showing both high nutritive properties and also adaptability to particular purposes. This may be illustrated by citing some of the particular rations which have been prepared, viz, rations for the maintenance of horses and cattle not engaged in work nor being fattened; rations for animals at hard work; rations for fattening animals; rations for poultry, both for egg production and for preparing poultry for market. Various forms of rations for each particular purpose were prepared with the object of securing the best balanced and also the most economical product. Our experiments demonstrated beyond a doubt that fine-ground maize stalks are by far the best material known for utilizing blood and molasses as animal foods. Although cattle foods are now very cheap and abundant in our country, it is somewhat interesting to know that in the almost inexhaustible quantity of this material we have a resource for the future which will supply every demand. In this material also we find a means of utilizing in the most economical way the waste products of our slaughterhouses, of our beet-sugar fac-

ories, and of the cane-sugar factories of Louisiana, of the Hawaiian Islands, and of our tropical dependencies.

EXAMINATION OF FOREIGN FOOD PRODUCTS.

A large amount of work has been done during the year in the examination of foreign food products. We desire to send abroad only those food products which are wholesome and free from adulteration. In like manner we ask that similar products sent to us from foreign countries be true to name and label and free from adulteration and injurious ingredients. To this end, an extensive study of such imported products has been authorized by Congress and has been rigorously prosecuted during the year. The results of these studies have been in a measure confidential, and instead of being published have been transmitted to the Secretary of Agriculture for his guidance in discharging the duties imposed upon him by the act of Congress authorizing the investigation.

The extension of this investigation to all imported food products will undoubtedly prove of the greatest advantage to our people, since it will result in the exclusion of harmful and adulterated articles and of those which are sold under false and misleading names or labels. In securing these samples, the Department has had the active cooperation of the Secretary of the Treasury and of the officials of the custom houses at the more important ports of entry.

STUDY OF THE SUGAR-BEET INDUSTRY.

The distribution of beet seed and the analysis of the beets produced therefrom in various parts of the country have been continued as in former years. These studies are now chiefly valuable for the interest they excite among our farmers and for the data which they afford relating to the influence of climate on the richness of sugar in the beet. It has been well established by the work of the Department, extending now over twenty years, that the saccharine strength of the beet tends to diminish as the cultivation is pushed southward of a certain isothermic line. The position of this line is not fixed with absolute exactness, and from the very nature of the problem can not be, but it seems to lie somewhere between the isotherms of 69° and 71° F., mean temperature, for the months of June, July, and August, the three months most important in the growth of the beet. Whether this deterioration be due to temperature alone or to combined influences of temperature and other meteorological conditions does not definitely appear. The more reasonable view is the latter one, and for this reason the isotherm alone ought not to be taken as an absolute limit in defining the zones of successful beet culture.

The data already at hand are sufficient for pointing out in a general way the region suitable to the production of beets under the conditions which generally obtain. It must not be forgotten, however, that exceptional meteorological conditions often arise which produce variations of the most pronounced order. This fact renders desirable the continuation of comparative studies under carefully controlled conditions, and such studies have been already inaugurated in connection with several experiment stations.

DETERIORATION OF THE GLUTEN CONTENT OF WHEAT.

Statements have reached the Department from various parts of the country showing a deterioration in the gluten content of wheat, which in some instances—as, for example, where the flour is used for the

manufacture of macaroni and spaghetti—has injuriously affected the market value of that most important cereal.

Under the authority of the Secretary of Agriculture, a study of the causes which produce this deterioration and of the means of preventing it has been commenced in connection with certain experiment stations, which have expressed a willingness to cooperate in this work. Samples of the same wheat have been planted in different parts of the country under widely varying meteorological conditions, and already the products of the first year's growth have been received for analysis. It is believed that much practical good to wheat growing will result from these studies.

COOPERATION WITH OTHER EXECUTIVE DEPARTMENTS.

During the year the cooperative work of the Division with the Executive Departments has been continued, under the direction of the Secretary of Agriculture.

For the War Department tests have been made of the chemical and physical properties of the cloth intended for the manufacture of uniforms for soldiers in the Tropics, and on the results of these analyses the contracts for the cloth were concluded.

Numerous analyses of food materials have also been made, at the request of the Secretary of War, for the guidance of the ration board in selecting materials for an appropriate emergency ration for the Army.

Analytical investigations have also been conducted during the year for the Departments of State and of Justice, the Post-Office and Navy Departments, and for the U. S. Fish Commission.

Collaboration with the Treasury Department in connection with the methods of collecting duties on imported sugars has been continued, and the chief of the Division gave more than a month of his time to the work during the year. The principle of the method of correcting polariscopic readings for the effect of temperature, which has been adopted by the Treasury Department for fixing duties on sugar, and which the investigations of the Division have shown to be rigidly correct, has been approved by the international committee appointed to determine uniform methods of sugar analysis. This committee, at its meeting in Paris in July, 1900, recommended that in all countries the polariscopes employed should be graduated for the temperature at which they are to be used. This is an unqualified approval by the highest international authority of the methods of sugar analysis established as correct by the investigations of the Division of Chemistry.

Within the past year American scientific workers have taken active steps to secure in this country a national standardizing bureau equal in point of equipment and working force to similar institutions established by foreign Governments, notably those of Germany, which have placed German scientific workers and those engaged in industrial and commercial operations dependent upon them at a decided advantage over our own in many respects. The Association of Official Agricultural Chemists and the American Chemical Society have been among the first and the most active scientific bodies working for the success of this movement. Two members of the Division of Chemistry are connected with committees appointed, one by each of the societies named, to ascertain the best means of increasing the uniformity and of improving the accuracy of chemical measuring instruments. These committees have reported to their respective bodies that the establishment of a national standardizing bureau is the first step toward accomplishing this end. During the past year

the Secretary of the Treasury recommended that Congress reorganize and equip the present Office of Weights and Measures in such a manner as to enable it to meet the demands of the present for the testing and certification of various forms of measuring instruments, and for conducting the research work necessarily connected with such operations as the changing conditions of scientific and industrial progress are to be met.

Considerable time was spent in preparing a statement relative to the usefulness of a national standardizing bureau to this Division of the Department of Agriculture in response to a request coming through the Secretary of Agriculture from the Secretary of the Treasury, who desired the information for use in connection with his recommendations. I wish to state again that I regard the establishment of such a bureau to be of the most fundamental, continued, and increasing importance for the successful conduct of the work of this Division in the future. As we proceed in the development of standards of quality and purity for foods and other agricultural products, and as analytical processes become more and more numerous and are made more and more accurate, the need of a ready and certain means of obtaining apparatus of a prescribed standard of accuracy becomes imperative.

What is true of our needs is true of every industrial and commercial operation in connection with which values have become dependent on the results of physical and chemical tests.

COOPERATION WITH THE LEGISLATIVE BRANCH OF THE GOVERNMENT.

The Division, under instructions from the Secretary, cooperated with the Senate Committee on Manufactures in its investigation of adulterated foods. Many samples of suspected foods were analyzed for the committee, and the chief of the Division assisted the chairman of the committee in the investigation on various occasions, more than a month of his time being devoted to this work.

The results of the activity of the Division in this direction were largely instrumental in securing the introduction of a pure-food bill into the Congress of the United States and its favorable consideration by the Committee on Interstate and Foreign Commerce in the House of Representatives and by the committees on Agriculture and Forestry and Manufactures in the Senate. In order to secure the highest standards for foods, both for home consumption and for export, it is hoped that this bill may speedily become a law.

COOPERATION WITH OTHER DIVISIONS.

The cooperative work with the other branches of the Department of Agriculture has been continued in several directions.

For the Bureau of Animal Industry a study of dairy products, especially of butters of different origin, has been conducted. Particular attention has been paid to the detection of so-called "process" butter and its chemical and physical peculiarities. A study of the composition of foreign cheeses has also been made, both from the point of view of adulteration and of food value.

In connection with the Division of Soils, collaborative work on soil analysis has been conducted, and working room for one of the chemists of that Division has been provided.

The Division of Entomology has assisted us in collecting samples of insecticides, and a number of analyses has been made at the request of the chief of that Division.

Determinations of the water content of indian corn and other cereals

have been made at the request of the Division of Botany. In turn, the Section of Seed and Plant Introduction of that Division has conducted for us the vitality tests of the beet seeds distributed to various parts of the country, and also of seeds used in connection with the soil experiments of this Division.

Rooms have been provided the Division of Forestry for clerical and other work, and preliminary arrangements have been made for extensive chemical investigation of trees and bark.

It is believed that a more thorough system of collaboration among the different Divisions of the Department would secure a more economical and effective conduct of investigation by confiding to the proper experts the control of investigations pertaining to their special work.

At the request of the Secretary, an investigation of the methods of testing road materials was made for the Office of Public Road Inquiries of the Department. The laboratories at Johns Hopkins and Harvard universities were visited, and the machinery and processes in vogue studied. In the report of this investigation it was recommended that a laboratory for testing road materials be erected in the Division of Chemistry and the study of road-making rocks and gravels be conducted in collaboration with the Office of Public Road Inquiries. The results of such studies can not fail to be of the greatest practical benefit in the building of good roads.

The Division of Chemistry during the year has not hesitated to ask for the help of other Divisions of the Department, and has found them always ready to respond to any reasonable demand.

MISCELLANEOUS WORK.

A good deal of time has been given during the year to miscellaneous work, which is not capable of classification. It is hard to refuse demands for investigations of this kind, even when they are not directly connected with agriculture, and yet a refusal is necessary in order not to interfere with strictly agricultural work. Where, without great outlay of time, investigations can be made, even when indirectly connected with agriculture, they are sometimes undertaken, but the tendency has been for the past few years to restrict this miscellaneous work to the smallest possible limits, looking thus to its ultimate extinction.

PLAN OF WORK FOR THE FISCAL YEAR ENDING JUNE 30, 1901.

The lines of work above indicated will be continued with such variation as the requirements of the public service and economy of administration may require.

The funds appropriated by Congress for this year provide for an additional investigation by the Division of the physical and chemical tests applied to American food products imported into foreign countries. This will lead to a study of the methods of analysis employed in such countries and a comparison of these methods with those official in the United States. If differences are found of essential importance, a further investigation must decide which of the methods is the more desirable. The act of Congress also provides that the Secretary of Agriculture shall inspect cargoes of American food products intended for shipment abroad when the exporters so desire. The object of this law is to secure for foreign exports only the best of food products and to have them accompanied with an official certificate of purity and excellence. By this means we will be able to protect our food prod-

nets in foreign countries from unfair examination and unjust discrimination. During the fiscal year these provisions of the act of Congress will be put into operation.

Another provision of the act authorizes the Secretary of Agriculture to study the effect of food preservatives upon health and to determine if any food preservatives are admissible, and if so in what foods and in what quantities. In carrying out this provision it is proposed to secure the collaboration of schools and colleges of hygiene where a perfect control of the conditions of experiment can be secured.

A priori, it seems evident that no really effective food preservative should be admitted in foods further than is necessary to serve as a condiment—as, for instance, sugar or common salt. At the same time there is a large class of foods which are difficultly preserved without the use of antiseptics. It is not fair to place all antiseptics in the same class and condemn them all because some are certainly bad. The object of this examination is therefore to determine, if possible, the effect of food preservatives on digestion and the amount, if any, of certain nearly harmless ones, which may be admitted into foods intended for human consumption. This question is one of the greatest importance, both from a hygienic point of view and from the needs of the manufacturers of a large line of agricultural products.

Until the hygienic relations of food preservatives can thus be accurately ascertained, it is clearly the imperative duty of manufacturers to state upon the labels of the packages of their goods prepared by the use of preservatives the kind and quantities of the preservative agents employed.

PLAN OF WORK FOR THE FISCAL YEAR ENDING JUNE 30, 1902.

The work outlined under the first and second general headings of this report should be prosecuted, with certain changes, during the fiscal year ending June 30, 1902.

An especial effort should be made to indicate in what direction improvements must be sought in the case of wheat and other cereals. The work of the Division several years ago in the improvement of the sorghum plant, the first of its kind undertaken by the Department, shows what may be accomplished in this direction.

To preserve the good name of our food products abroad, the inspection of the exported food products should be perfected and extended, and to this end a national pure-food law to secure the same results at home would be a most valuable adjunct.

The influence of temperature and other meteorological forces in the composition of the beet, which is now under observation, should be studied more systematically. To that end the cooperation of at least some of the experiment stations situated in our arid regions and under irrigation should be secured. In such stations all the meteorological conditions, except temperature, can be readily controlled. It is quite possible that with such an adjustment of moisture and other conditions as would secure a rapid and unchecked progress of the beet to maturity, a very high sugar content might be secured at temperatures much above those giving the best results under ordinary normal conditions.

Greater facilities for cooperative work with the other offices of the Department and with the other Departments should be provided. The Department of Agriculture, without any solicitation on its part, has come to be regarded as the chemical adviser of many of the other Departments. It is evident that both economy of administration and effectiveness of work can be secured by fostering this sentiment.





